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ABSTRACT

This research review examines the effects of instructional variables on the learning of handicapped and nonhandicapped individuals. The research review begins with an historical look at learning disabilities research. An overall analysis of the differential effects of instructional variables on learning-disabled and nonhandicapped individuals concludes that learning-disabled children, when taught by traditional instructional methods, frequently encounter problems in motivation, overloading, poor selective attention, interference with new and old learning, and transfer. Significant instructional variables are then singled out for examination; these include reinforcement; mastery; practice; focused attention, modeling, and informative feedback; and teaching of learning strategies. Other characteristics of the instructional program are also discussed, such as overloading, interference, transfer of learning, and the importance of prerequisite skills in learning hierarchies. (JDD)

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THE EFFECTS OF INSTRUCTIONAL VARIABLES
ON THE LEARNING OF
HANDICAPPED AND NON-HANDICAPPED INDIVIDUALS

N. Dale Bryant, Sal Canale, Rosemary Driscoll, Harriet
Fayne, Joanna Fisher, Maribeth Gettinger, Janet Gluckman,
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Research Review Series 1979
Volume 1

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Principal Investigators

Dale Bryant, Ph.D.
Jeannette Fleischner, Ed.D.
Walter MacGinitie, Ph.D.
Margaret Jo Shepherd, Ed.D.
Joanna Williams, Ph.D.

Frances P. Connor, Ed.D.
Institute Director

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Focus of LD Research: An Historical Perspective

In order to understand why so little research emphasis has been placed on general learning principles in relationship to the LD population, it is necessary to look at the focus of research in the last twenty years. Black (1974) surveyed the literature from 1962-1972 and found that a majority of journal articles on learning disabilities dealt with descriptions of the population, prediction and diagnosis of learning disorders, or comparison of disabled children with other groups on various measures. Less than 25% pertained to remedial methods. Chall (1978) notes that great emphasis has been placed on correlates of poor skill achievement (e.g., visual and auditory perceptual skills) rather than on the skill areas themselves. This correlational approach is also reflected in the types of remedial techniques under consideration in research articles during the ten-year period Black (1974) covered.

Generally, remediation techniques that received attention involved perceptual-motor training (Kephart, 1960; Frostig & Horne, 1964), neurologically-based physical training (Delacato, 1966), modality preferences (Johnson & Myklebust, 1967; Kirk & Kirk, 1971) and multi-sensory approaches (Fernald, 1943; Gillingham & Stillman, 1969).

Unfortunately, the emphasis placed on correlates of poor achievement has led to inconclusive results or unsubstantiated hypotheses. In their review of research designed to evaluate perceptual-motor training programs Hammil, Goodman and Wiederholt (1974) conclude that the value of perceptual training in terms of academic achievement has not been clearly established. Doman and Delacato's motor training (patterning) also has not proved to enhance children's ability in academic subjects (O'Donnell and Eisenson, 1969). Gruber (1969) points out several problems in studies which have attempted to connect motor training with academic achievement. These include lack of a standardized definition of LD including factors such as social deprivation, emotional disturbance, etc. other

than neurological factors: (a) invalid measure for LD, (b) flaws in experimental design, (c) inappropriate data analyses, (d) lack of motivational incentives for good performance, (e) inadequate representation of sexes and (f) need for larger sample sizes.

Diagnostic-prescriptive teaching generally utilizes modality preference and correlational data as its basis. There is a substantial amount of research which indicates that the theoretical underpinnings of this approach are not supported by a solid data base.

Preferred modality approaches assume that the LD child demonstrates a specific perceptual deficit which affects his ability to acquire skills. A visual deficit has been proposed as a cause of reading failure. Vellutino, Steger and Kandel (1972) found no difference between normal and poor readers when asked to reproduce graphically, 3 or 4 letter words presented in a visual mode. However, significant differences were found when subjects were asked to pronounce these words. The authors suggest that the problem is not so much due to a visual deficit as an inability to encode verbally. Two studies using unfamiliar letters (Vellutino, Pruzek, Steger and Meshoulam, 1973; Vellutino, Steger, Kaman and DeSetto, 1975) indicated that poor readers had the same visual scanning abilities and made the same type of recall errors as did able readers.

Auditory deficit research also appears to be inconclusive. Hammill and Larsen (1974) reviewed 33 studies that related auditory discrimination, auditory memory, blending, and auditory-visual integration to reading ability. Differences in auditory skills among good and poor readers were somewhat suspect because over half of the studies neglected to control for I.Q. The authors conclude that there is no good evidence to suggest that auditory skills as measured are substantially related to reading achievement. They caution

the use of specific auditory training as a teaching strategy for improving reading achievement.

Cross-modal integration studies also yield inconclusive findings. Several studies of cross-modal matching (Blank and Bridger, 1966; Blank, Weider and Bridger, 1968; McGrady and Olsen, 1970; Steger, Vellutino and Meshoulam, 1972) indicate that deficiencies may be due to verbal encoding more than cross-modal matching. Thus, even when two modalities are integrated, the deficit hypothesis yields questionable results.

Tarver and Dawson (1978), after surveying 15 studies that fall within the modality preference framework, conclude that there is no proven interaction of aptitude (modality preference) and treatment (reading method). The authors account for the inability to demonstrate interactions in two ways: 1) failure to consider learner variables besides modality preferences; and 2) failure to look at the demands of the tasks themselves.

The Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, and Kirk, 1968) has had a great influence upon the diagnosis and treatment of learning-disabled youngsters. The test is based on the principle that youngsters will demonstrate a profile of strengths and weaknesses in auditory, visual and expressive areas. With a median subtest reliability of .71, the test does not lend itself to interpretations which build remedial programs around specific subtest scores (Sedlak and Weener, 1973). There are no studies which show that remedial programs based on ITPA subtest scores are effective (Newcomer and Hammill, 1975), yet many remedial activities are based on such a premise (Kirk and Kirk, 1971; Minskoff, Wiseman and Minskoff, 1972; Bush and Giles, 1969).

The multisensory technique is based on the assumption that learning can be facilitated by presenting information through multiple sensory inputs

(Fernald, 1943; Gillingham and Stillman, 1969). The technique often referred to as VAKT, encourages the child to "look-say-copy, write or trace" while learning phonic elements, words, or arithmetic facts. While the VAKT approach had been widely used by special educators, underlying assumptions have rarely been validated in the research literature (Bryan and Bryan, 1978). A thorough survey of literature on the multi-sensory approach follows in the section on basic skill areas.

Chall (1978) notes a recent shift away from the trends of the 1960's and a return to interest in the academic skill areas. In the area of reading, she points out that teacher effectiveness has proven to be a significant variable and concludes "... probably the best form of treatment is good teaching by a qualified special remedial teacher and by a good classroom teacher (p. 40)." However, the concept of "good teaching" needs to be operationalized in order to be validated. Rupley and Blair (1978) point out that research focusing on variables within the instructional process itself chosen by a teacher has been sparse.

The Differential Effects of Instructional Variables on the Learning of
Normal and Handicapped Students

Walberg (1971) proposes two models for integrating educational research from three traditional avenues of inquiry. The first integrates the additive conclusions or results of research on aptitude correlates, instructional variables, and environmental factors. The second is a multiplicative model which emphasizes the interactions of these three research domains. While correlational research may account for differences in performance, the factors are not manipulable. Instructional experiments, on the other hand, manipulate variables but fail to arrive at significant differences. It would appear, from a half-century of instructional research (Stephens, 1968), that factors commonly believed to promote learning make little or no difference. Research on the efficacy of various techniques (i.e., group vs. teacher-centered instruction, programmed vs. non-programmed approaches, discovery vs. traditional teaching) leads to the conclusion that all methods essentially produce the same levels of student achievement.

The first grade reading studies (Bond and Dykstra, 1967) are a well documented case in point for the relative unimportance of teaching method in relationship to achievement. From a coordinated project involving twenty-seven separate investigations of first-grade reading using a wide variety of approaches, the following conclusions can be drawn: 1) there is no one method so effective that it can be recommended above all others; and 2) there exists greater variation between teachers within methods than between methods themselves.

Naturally, these findings are most applicable to normal learners. It would seem that the average child will learn basic skills despite, rather than because of, the efficacy of instruction. Learning disabled youngsters,

however, do not appear to learn regardless of the nature of instruction. For problem learners, careful application of well-documented principles of learning should have positive effects on achievement.

Bloom's (1976) theory of school learning focuses on the determination and application of variables which will account for most of the variation in school learning. Bloom stresses that "equality of learning outcomes" should be the goal of instruction rather than "equality of opportunity." To achieve this goal, then, an "inequality of treatment" may be needed if low achievers. In emphasizing individual differences in learning, Bloom states that there will always be children (from 1 to 3% of students in a typical class) who will learn at a slower rate and at a lower level of complexity and achievement than the average child. Such students, he proposes, can make effective learning progress, but, unlike the average, will need more time, attention, and resources to make it possible.

Haring and Bateman (1977) also stress the importance of appropriate learning principles for LD children. In fact, they distinguish LD children from normals in that LD children are those who must be taught by the "best methods available" if they are to succeed. "Teaching disabilities," they suggest, is a more precise term than learning disabilities to describe their failure in school. For example, in discussing commonly used approaches to teaching reading, they state:

Regardless of the merits of the whole word or meaning-emphasis approach for the majority of children who do seem to learn to read by "osmosis" and without intensive, systematic or structured instruction, the clear fact is this method has been disastrous for learning disabled children (p. 148).

Despite an interest in individualized instruction, there have been few systematic attempts to adapt instruction to pupil characteristics. Existing adaptations generally consist of varying instructional rate or modality rather than instructional method. When instructional method has been modified, the adaptations are rarely based on a systematically formulated set of principles that have been verified by empirical research (Tobias, 1976).

Research concerned with adapting instructional treatments to individual differences among students has been termed "aptitude treatment interaction" (ATI). In a number of ATI studies on nonhandicapped learners (Tobias and Abramson, 1971; Leherissey, O'Neil, Heinrich & Hansen, 1973; Tobias, 1973; Tobias and Duchastel, 1974) a few consistent interactions between different types of learners and instructional treatments were found. The most relevant findings were that instructional supports (e.g., logical sequence, corrective feedback, behavioral objectives) yielded superior achievement in children who scored low on a pretest over the subject matter; when familiarity with material to be learned was high, these modifications in instruction did not lead to superior achievement.

A general hypothesis based on these studies, then, is that the higher the level of prior achievement, the lower the instructional support needed to accomplish instructional objectives. Conversely, as achievement in a particular subject area decreases the amount of instructional support must be increased since LD children are characterized by low achievement, it may follow that disabled children will profit most from maximal instructional support.

ATI literature, then (Salomon, 1972; Tobias, 1976; Bracht, 1970) suggests that the further away a learner is from mastery of an object, the more the learner benefits from structured "learning roles" approaches. This principle is related to the often heard generalization that academically able youngsters can learn to read with any approach while difficult-to-teach children need a "structured" phonics lesson (Bateman, 1975; Kirk, 1962). It has not been definitely established that all learning disabled children have these particular instructional deficits. A reasonable interpretation of available data, clinical experience, and expert opinion, however, suggests many might.

Bryant (1965b) states that a frame of reference--principles as well as techniques--for planning remediation for problem learners is needed. Although there is a large amount of individual variation in problem learners, some basic learning principles may prove beneficial to the majority of LD children. Bond and Tinker (1973) state:

The many kinds of reading confusions children manifest indicate that no two disabilities will be corrected exactly the same way. Nonetheless, there are some basic principles underlying remedial instruction irrespective of the specific nature of a particular reading disability (p. 268).

A review of the literature reveals a striking amount of agreement among experts in the field on the best instructional methods and principles for teaching problem learners. While data supporting these suggested principles is scarce, several commonalities do emerge. For example, for optimal learning, a student must be motivated. Degree of motivation depends to a large extent on amount of success. For the LD child, instruction by traditional methods often results in failure, and consequently, low motivation and success. In order to prevent frequent failure, many experts believe that instruction material to be learned should be presented in very small, structured steps (Otto, McMenemy, & Smith, 1973; Bryant, 1965b; Valett, 1969). The steps should be so small, in fact, that "a correct response is virtually assured" (Otto et. al., 1973, p. 56).

In addition, it is important that instructional materials be at the appropriate ability level for the child (Bond and Tinker, 1973; Otto et al., 1973). If the instructional materials are not too easy or difficult, and lessons are structured in small steps, then success, not failure, will occur more frequently.

Otto et al. (1973) believe a backlog of success experiences will often build a tolerance for failure. In general, then, lessons should be simplified so that confusion is avoided, and basic perceptions and associations are learned so well they will not be forgotten (Bryant, 1965a,b).

In addition, if the learning experience is to be reasonably self-sustaining, each success should be rewarded whenever possible (Otto et al., 1973). Otto et al. also believe that children should become "self-reinforcing" due to the time demands on the teacher, and whenever possible, should observe their own progress. To prevent the learning of incorrect responses, many experts recommend that immediate feedback be given whenever possible (Valett, 1969; Frostig and Maslow, 1973; Haring and Bateman, 1977).

The concept of "overloading" is frequently used in the description of learning problems for LD children (Bryant, 1965b; Johnson and Myklebust, 1967). Overloading results when the number of non-automatic discriminations that must be made are more than can be processed at one time (Bryant, 1965a,b). For example, Bryant points out that good readers have an automatic response to most common words, which prevents them from making confusions with other discriminations or associations. This is not the case for the LD child, however. When too many non-automatic discriminations must be made at one time, even simple discriminations or associations that could previously be made cannot be done by the LD child. To prevent overloading, experts recommend that the number of non-automatic discriminations required (e.g., the number of associations to be learned at one time) should be below the threshold for overloading (Bryant, 1965b; Johnson and Myklebust, 1967). Tasks should proceed from the simple to the complex (Frostig and Maslow, 1973), while component steps in the task must be

analyzed. For example, the teaching of handwriting obviously cannot be taught by using whole words, but must begin with separate strokes that make up each letter. In general, then, experts stress that the lower tolerance level for LD children must be incorporated into the structure of the lessons to prevent failure.

Ross (1977) defines the LD child as one who is "impaired by a developmental lag in the ability to sustain selective attention," (p. 11). Strauss and Lehtinen (1967) believe the brain-injured child may have an "exaggerated responsiveness to stimuli" (p.374) and therefore be more distractible than normals. Therefore, experts recommend that, whenever possible, environmental stimuli should be reduced (Strauss and Lehtinen, 1967; Johnson and Myklebust, 1967). Strauss and Lehtinen (1967) recommend a minimum of visual stimulus materials, with only the bare essentials, in the belief that with decreased interference from environmental stimuli, increased responsiveness to the learning situation will result.

Proactive inhibition occurs when past learning interferes with new learning, whereas retroactive inhibition results when new learning influences old. With traditional instructional methods, both occur more frequently for LD children. Experts believe that to prevent interference between different learnings, an explicit connection must be made between the sequence of items learned (Frostig and Maslow, 1973; Bond and Tinker, 1973). Some researchers believe that with certain tasks, the best means to facilitate remembering is to provide for overlearning (Otto et al., 1973; Bryant, 1965b; Haring and Bateman, 1977). For example, if the association of several sounds for a particular letter is to be learned, the number of discriminations and associations required must be limited until each sound association has been well established (Bryant, 1965b). Overlearning can also be accomplished by frequent review and drills before moving on to more difficult material.

Because LD children have more difficulty in abstracting similarities and differences, Frostig and Maslow (1973) believe that these must be clarified

and emphasized. The unique features of each new learning should be stressed and understood, e.g., the differences between b and d (Otto et. al., 1973). Frostig and Maslow (1973) believe that language (labeling) might also aid in pointing out similarities and differences.

Experts believe that emphasizing similarities and differences is also crucial for enhancing transfer (Frostig and Maslow, 1973; Bryant, 1965b; Kirk, 1962; Valett, 1969). Frostig and Maslow (1973) describe transfer as forming "the whole criterion of instruction" (p. 153). For example, when $6 + 0 = 6$ and $4 + 0 = 4$ is taught, what is crucial to abstract is the rule that adding zero to a number does not change the number. Frostig and Maslow (1973) recommend that when different stimuli require different responses, emphasis should be on differences between stimuli, whereas when different stimuli require the same response, the emphasis should be on similarities. Bryant (1965b) stresses that attention should be drawn to relevant factors (e.g., details within a word) because LD children often focus on minimal or irrelevant cues. Simply writing a word several times, calls attention to each letter with the word. Kirk (1962) is in agreement here in stressing that for LD children, incidental learning must not be relied upon. Opportunities should be provided for skills already learned to be used in varied and related situations (Valett, 1969). And, to a large extent, transfer of learning to new tasks depends on the degree of learning in the prior task, therefore overlearning, mentioned earlier, will enhance transfer.

In summary, the LD child, when taught by traditional instructional methods, frequently encounters problems in motivation (due to frequent failure), overloading, poor selective attention, interference with new and old learning, and transfer. Experts in the field recommend the use of good learning principles such as reinforcement, immediate feedback, overlearning, drawing attention to relevant factors, and presenting lessons in small sequential steps, to alleviate some of these problems. In addition, to improve the learning environment in

general, researchers recommend having a complete understanding of the strengths and weaknesses of each child (Valett, 1969; Bond and Tinker, 1973; Otto et al., 1973; Haring and Bateman, 1977), the child's complete awareness of what is expected, (Valett, 1969; Haring and Bateman, 1977), and the inclusion of instructional material that is meaningful to the LD child (Bond and Tinker, 1973; Otto et. al., 1973).

Significant Instructional Variables

Reinforcement

As a basic learning condition, reinforcement is an important prerequisite to skill acquisition. Overwhelming evidence supports the idea, which was stated by Thorndike in 1911 as the Law of Effect (1911), that rewarded responses tend to be repeated whereas unrewarded responses tend to be discontinued.

Tharp and Wetzel (1969) identify three specific types of reinforcers:

- 1) activity - a high probability behavior tied to a low probability behavior;
- 2) material - trinkets, toys, or tokens to be traded for desired items; and
- 3) people - praise, attention, reproof. The effectiveness of all these types of reinforcers may depend on immediacy, frequency, and amount (DeCecco, 1968).

There are numerous studies which demonstrate that the utilization of reinforcement improves school learning. With special education populations, reinforcement has proven effective in increasing on-task behaviors (Alexander and Apfel, 1976), listening skills (Bussell, Huls and Long, 1975), verbal expression, perceptual-motor skills (Larsen and Bricker, 1968), as well as subject material learning (Camp, 1973).

In particular, token reinforcement has been used with good results on a variety of target behaviors with a wide range of populations. Benowitz and Busse (1970) concluded that material reinforcers were more effective with children than verbal reinforcers. Staats (1968, 1971) found tokens especially useful for the acquisition of early reading skills. Tokens gain effectiveness when paired with backup reinforcers in the school or community setting.

Because the importance of reinforcement on school learning has been well-documented and because reinforcement procedures are widely used in both regular and special education settings, the Institute will not focus its investigation on this particular instructional variable. However, sound reinforcement procedures will be followed within all investigations.

Mastery

The research indicates that an emphasis on mastery will help students to compensate for learning deficits. If given enough time and appropriate help, students can ideally achieve mastery. It is clear that students differ in the amount of time needed to learn a subject to a level of mastery. Studies on variations in learning time show that, on the average, the fastest students master material 5-6 times as quickly as the slowest (Anderson, 1976; Carroll, 1963a; Carroll, 1970). If a student is not allowed the time he needs for a particular subject, his learning is likely to be incomplete. If he is allowed enough time, his learning will be more complete and achievement will be higher. Mastery learning theory (Bloom, 1968) and supporting research (to be cited) propose that, although instructional time and amount of repetition may vary, nearly all children can reach a criterion of mastery. But a basic problem that Bloom points out is to find ways of reducing the learning time slower students require so that the task will not be overwhelming.

Carroll (1963a) formulated a model of school learning that examines individual differences in time needed for mastery. It is based on an analysis of a hierarchical structure of learning tasks and the time it takes to master them. The basic thesis in Carroll's model is that time is a central variable in school learning and that pupils differ in the amount of time they need to master a given learning task to some set criterion. According to the model, the degree of learning is a function of 2 time factors: the amount of time actually spent in learning and the amount of time needed. The latter may be an artificial construct since too many unknown variables enter into it and may be difficult to measure. But rate of learning may be realistically dependent on the task (relevant prior learning) and subject variables. Suppes (1964) found that in learning maths, rate of learning varied even when instruction was near optimal.

Anderson (1976) understands "time to criterion" as including time on and off task. This may be modified by an effective teaching-learning strategy

which includes preparatory units (warm-up) that help them reach criterion. Teachers would then need to allot less additional total time since students would be spending more time on task.

Bloom (1968) transformed Carroll's conceptual model into the instructional paradigm called mastery learning. The goal of mastery learning strategies is to fix the degree of learning at some mastery level and manipulate variables, such as amount of instructional time, repetition, and practice, so that nearly all pupils (95%) attain it. The major theoretical idea behind successful applications of mastery learning strategies (Atkinson, 1968; Glaser, 1968; Morrison, 1926; Washburne, 1922) is that within a curriculum, instructional time should be the variable unit whereas achievement should be the constant one.

The variation in instructional time required poses one of the major problems in incorporating mastery into a group curriculum--how to ensure mastery for all students. Mastery learning rests on the conviction that educators should make it possible for nearly all pupils to attain the basic skills and knowledge that are essential goals of every school curriculum. Therefore, a major goal is to develop group experimental procedures which will be efficient in accomplishing mastery within reasonable time limits.

Although effective mastery strategies have been developed only recently, the notion of learning mastery is not new. Attempts to produce mastery in pupils share many features; definition of particular objectives, well-defined learning tasks, complete mastery of one task before going on to another, immediate feedback and correction, and original instruction supplemented and/or repeated to master the unit.

Results from over forty major studies through the early 1970's conducted in classrooms show that mastery learning strategies have marked effects on overall school achievement. In general, mastery strategies enable about three-fourths of students to learn to the same performance standards as the top one-fourth of students learning under traditional approaches. Students having

learning problems under conventional instructional conditions benefitted the most from mastery strategies. For example, students with below average IQ scores, achievement, or motivation learned as well under mastery conditions as those with above average IQ and achievement (Block, 1971; Bloom, 1973, 1974; Carroll, 1963b; Suppes, 1964).

Classroom studies also indicate that mastery approaches make student learning more efficient. Mastery of early units in a school subject or early items in a single lesson facilitates learning of subsequent items, particularly when they are sequentially arranged. Instructional time spent to ensure mastery learning of early items seems to result in the need to spend less time on later items. The extra time and help provided in mastery learning contribute to later learning. It has been shown (Anderson, 1976; Block, 1971; Bloom, 1973, 1974) that equal amounts of time do not have equal results on learning at all stages. A particular amount of time provided at an early stage in a learning sequence has a different effect than an equal amount of time provided at a later stage. The argument is that extra time on only later units in a learning sequence would not improve performance if the earlier units were not mastered.

Mastery methods have an additional effect of producing greater interest in and better attitudes toward school learning than traditional approaches, particularly among students who, because of learning problems, have had little success or reward in school. These affective consequences may be attributed to many factors inherent in mastery learning--e.g., immediate feedback, successful learning, individual attention, active participation by learners (Block, 1971).

Practice

According to Underwood (1966): "With possibly no exceptions, the longer we practice a task, the better we learn it" (p. 486). When we apply this to special educational practice it becomes necessary to define the terms "practice," "longer," and "better" more carefully.

Experts in the field of remedial education have long agreed that sufficient practice is necessary in order to master skills (Otto, McMenemy, and Smith, 1973; Bryant, 1965b; Haring and Bateman, 1977).

Generally speaking, the practice variable itself is defined by 1) the number, type and distribution of trials, 2) the method and general conditions of practice, and 3) feedback (primarily through clarification and correction). Ausubel, Novak, and Manesian, (1978) believe that practice affects learning and retention by modifying cognitive structures in four ways:

- 1) increases the dissociability strength of the newly learned meanings for a given trial and therefore by facilitating their retention
- 2) enhances learner responsiveness to subsequent presentations of the same material.
- 3) enables the learner to profit from intertrial forgetting
- 4) facilitates the learning and retention of related new learning tasks (Ausubel et. al, 1978).

More complex ideas require a specific number of appropriately spaced reviews in order to be retained and transferred. While progressive education has viewed drill methods disdainfully it does serve a useful purpose when applied carefully. In initial learning, drill is most effective when structured first around tasks with high similarity and then applied to same rather than being used haphazardly to bring about short term performance gains.

Overlearning (i.e., repetitive errorless performance beyond mastery level) is thought to enhance retention. Bryant (1965b) has pointed out that remedial instruction for dyslexia should address itself to the dyslexic's need for much

practice. According to Bryant, perceptual and associational responses should be overlearned until they are automatic. (Automaticity e.g., for number facts, sight words, is useful in that it allows the child to focus on more complex material). In order to develop an automaticity for basic discrimination of letters and for the association of sounds, the child needs to overlearn those basic skills and to practice them in complex words. Additionally, Otto et al. (1973) suggested that in the first stages of reading instruction, "service" words such as (this, then, etc.) should be overlearned to where they are instantly recognized.

In addition, when two discriminations or associations are mutually interfering, the elements should be overlearned to the point of automaticity to facilitate discrimination. Bryant (1965b) also mentions that frequent reviews of basic perceptual, associational and blending skills should be conducted.

Otto, McMenemy and Smith (1973) specified a number of areas in which the remedial student should overlearn the material. For example, production of letter forms in handwriting should be overlearned to the point of being automatized. Service words in reading such as: this, that, then, and, but, should be overlearned to the point where they are recognized instantly. The multiplication tables and proper language forms should be overlearned to the point of instant recall and automatic use.

Where it has been observed that normal children profit from overlearning, one may be confident that it will be even more beneficial for the learning disabled child. Durken (1976) stressed the notion that children need adequate practice in order to be able to utilize material learned in phonics lessons.

How this practice is structured is dependent on the age and ability of the learner and the nature, quantity and difficulty of the task.

A great source of discussion in the literature has pertained to the relative effectiveness of massed vs distributed practice.

Studies have indicated that superior results accrue when practice is distributed over time rather than massed in one practice period (Hull, 1943).

Distributed practice resulted in pronounced reduction in the number of trials required for mastery (Hovland, 1939). In a study by Turnure and Thurlow (1973), children who were given training on two separate days prior to presentation of a test list and after seven days beyond the original training period, were significantly more successful than children whose practice was limited to the original training period. Research by Otto and his colleagues has suggested that spaced practice may be preferable because it permits reactive inhibition to dissipate (Otto and Frederick, 1963; Otto, 1965; Otto, 1966). According to Hull (1943), reactive inhibition results from sustained performance which in turn decreases learning efficiency.

Distributed practice appears to be crucial where there is high response similarity (Underwood, 1961; Keppel, 1964). For example, when sight words have a similar configuration (i.e., horse-house) or when letter forms are similar (i.e., b-d), spaced practice may result in more efficient learning.

In a comprehensive review of the literature until 1961 Underwood concluded that there are two critical variables in determining whether or not distributed practice will facilitate learning: interference level and length of interval. The latter was substantiated by Ausubel who stated that learning and retention are positive functions of intertrial interval. Grassi (1971) also found that spaced practice was superior over massed in a task involving auditory and visual paired associate learning. Spacing consisted of a one minute rest period after each trial. This condition seemed to be beneficial to a limited extent.

In general, distributed practice seems to work best for younger and less able learners in tasks that were rote, long and difficult and for those tasks that required a longer warm-up period (Ausubel, et al. 1978). Its effectiveness may be most felt in better long term retention (Braverman and Klaiber, 1966).

Experimental evidence describing the questionable effectiveness of a massed practice overlearning procedure (for sight word teaching) comes from Kratochwill.

Four sight words (plus two distractor words) were taught under three conditions

which varied the number of overlearning trials past mastery. Recall and recognition were assessed after an hour. Results indicated that massed practice had little impact on retention. Traditional drill methods was thought to be time consuming and boring without improved results. The author suggested supplemental instructional strategies that might be more applicable (e.g., teaching words in context).

Of special relevance to remedial education is the consistent finding that overlearning facilitates positive transfer. According to Ellis (1965) "The results concerning the degree of original learning are fairly systematic. A general rule of thumb is that positive transfer increases with increasing practice on the original task. This is particularly true when an attempt is made to integrate new and old material--but only when the new material is sequentially dependent on the previously learned information. Therefore, in the classroom it is important for the teacher to distinguish between sequentially dependent and independent situations. Within this, the time factor also becomes crucial. Early review and feedback may be superior in terms of reducing forgetting. Delayed review may help supplement partially forgotten material. They are clearly complementary and are dependent on subject and task variables (Ausubel, et al., 1978).

Mandler (1962) postulates that a negative interference effect may be produced if the degree of response competition is greater than the degree of original learning and if warm-up and learning sets do not appear until the later stages of learning (e.g., during overlearning).

Focused Attention, Modeling, and Informative Feedback

Assuming that the motivation to learn is present, learning begins when the learner receives stimulation that will be transformed and stored in memory (Gagne, 1974). The learner must attend to the elements that are relevant to his purpose. Hebb (1972) conceived of the process of attention as a "mental set." This set which functions as a "control process" (Gagne, 1974, p. 32) may be activated by external stimuli which signal the learner to focus on specific information.

In his theoretical formulation of modeling, Bandura (1969) states that the first functional component of observational learning involves attentional processes. In order for a student to acquire modeled behavior, he must attend, recognize, and/or differentiate the distinctive and essential features. Children must learn to direct their attention in response to verbal and written instructions. In certain cases, special efforts may be required to insure that the ability to attend has been learned (Gagne, 1974). The learner's attentional set determines which aspects of the presented external stimuli are perceived: it is a matter of "selective perception," (Gagne, 1974, p. 33). For selective perception to be possible, the various features of the external stimuli must be distinguished or discriminated. Once the external stimuli have been attended to and perceived, learning can proceed.

It is doubtful if many classes of responses would ever be acquired if training proceeded solely by the method of successive approximations through differential reinforcement of emitted responses. Bandura (1969) stated that, in instances where a complex behavioral pattern contains a highly unusual combination of elements selected from an almost infinite number of alternatives, the probability of occurrence of the desired response, or even one that has some remote resemblance to it, will be zero. The response acquisition process can be shortened and accelerated by the provision of a series of models which are of graduated complexity. A wide variety of response patterns have been taught through modeling procedures--often used in combination with reinforcers, speech vocalizations (Lovaas, Berberich, Perloff and Schaeffer, 1966) and decreased phobic reaction in

children (Bandura, Gursek and Menlove, 1967). While modeling is a technique frequently used in education (providing examples, descriptions), most research in the area has been conducted in non-academic areas. Bandura (1969) states that for response acquisition, modeling is quite efficient and can be considered to be non-trial learning.

Informational feedback is what many learning theorists consider the essence of reinforcement, a process which is highly significant in human learning (Skinner, 1968). Informative feedback is often obtained by comparison with a standard or model. In general, learning processes are more likely to be supported when the learner is told how close he comes to a target performance, as opposed to being told that he is doing well or poorly (Gagne, 1974). Ammons (1954) concluded that the importance of feedback has been well documented in the research literature and has become a basic axiom in the psychology of learning.

From the theoretical literature, the following sequence of teaching strategies can be inferred: 1) encourage the child to attend to critical features; 2) provide adequate models; and 3) give informative feedback. All three elements require careful study. Because many learning disabled youngsters demonstrate attentional deficits (Ross, 1976) and are often unsure of the exactness of the information they do acquire, these principles may be differentially more important for LD as opposed to normal learners.

One technique which has been utilized to facilitate selection perception of stimuli is the use of prompts. Prompting is a form of external organization of stimuli so that information is given to learners before or at the time of responding. Prompts are cues which guide learners to a correct response. Markle (1964) defines prompting as supplementary stimuli which both facilitate responses and make the learner utilize previously learned material. De Cecco (1968) proposed that prompts serve a two-fold purpose: 1) they guide subjects to correct responses and 2) they prevent needless errors. Evidence for the value of prompting is found in studies which compare the effects of prompting (response guidance) and confirmation

(feedback as to correctness). Using a paired-associate-learning paradigm (letters code-line drawings), Cook and Kendler (1956) compared prompting with confirmation. Subjects in the prompting condition performed significantly better in early and later trials than those in the confirmation condition. In a later study, Angell and Lumsdaine (1961) found a prompting and confirmation procedure to be superior to prompting alone.

Several studies have investigated the effectiveness of using feedback and including correct responses (models), or providing only correct models. Travers, Van Wagensen, Haygood, and McCormick (1964) compared four feedback conditions with elementary school children. In one condition, subjects were told that their responses were correct or incorrect; the second condition informed subjects of incorrect responses only; the third condition informed subjects of correct and incorrect responses, with the correct models presented when errors occurred. Conditions 3 and 4, where correct responses were modeled, resulted in significantly increased learning. Thus, feedback as to performance plus correct models were more effective procedures than feedback alone.

Brown, Hermanson, Klemme, Haubrich, and Ora (1970) report on the effectiveness of using feedback and modeling to teach sight word vocabulary to educable mentally retarded subjects. Stimulus words were presented and labeled, with subjects reinforced for correct repetition of the label. When errors occurred, subjects were informed of the error (feedback) and provided with the model. The use of feedback, reinforcement, and modeling the correct response were successful in teaching sight words to subjects. Smith and Lovitt (1975) investigated the influence of modeling procedures (providing demonstration and examples) on the acquisition of arithmetic computational skills in learning disabled boys. Three studies were included in their report. In the first study, a demonstration-plus-permanent-model intervention was employed. The teacher computed the first computation problem, with verbal explanation of the process and left the demonstrated problem as a permanent model for the subject. When the intervention was applied, all subjects' scores increased to a median level of 90% or better (from a baseline of zero). The second study was a replication of Study I where demonstration-plus-permanent-model intervention increased the subjects' performance to a median of 100%. An initial condition where the subjects received feedback on their performance (check mark for correct responses, slash marks for incorrect responses) did not improve their subsequent computational behavior and was discontinued. The third study was a component analysis of the demonstration-plus-permanent-model technique, where demonstration was separated from the permanent model. The results were inconclusive, since some subjects achieved mastery with each separate component. Within-class generalization occurred in each study: similar-type problems were computed correctly (both types 2 digit subtraction). However, across-class generalization was inconsistent (2 digit multiplication to 3 digit multiplication). In summary, in all cases where the demonstration-plus-permanent-model technique was applied, computational behavior changed immediately and remained at a high level of performance during weekly post-tests.

Kauffman, Hallahan, Haas, Brame, and Boren (1978) report two experiments which compared the effectiveness of providing a correct model for spelling errors versus imitating subjects' errors, followed by the presentation of the correct model. In the imitation plus model condition, the experimenter said, "This is how you spelled the word," and repeated the subject's incorrect response and then said, "and this is the right way to spell it _____. " In both experiments, the imitation and model condition resulted in faster acquisition of correct spelling and a higher final level of performance than the model only condition. The advantage of imitating the child's error before presenting the correct model could be explained as an example of focusing the child's attention on the changed elements between the error and model, that is, some discrimination learning may have been occurring.

It is difficult to separate out the relative importance of each of the characteristics described in this section. Evidence leads one to the conclusion that all three variables--focus, modeling and feedback--are necessary elements in an instructional program designed for learning disabled youngsters. Although the same factors may aid the normal child's functioning, they appear to be more critical for handicapped learners.

Teaching Learning Strategies

Strategies have been conceptualized as important intervening variables between the task environment and task-related behaviors (Gilmartin, Newell, and Simon, 1976). The use of strategies greatly facilitates the processing of information, and utilization of efficient learning tactics, or strategies, has been observed to increase with age (Flavell, 1970). A reliable generalization is that learning disabled children exhibit a marked failure to utilize strategies (Wirtenberg and Faw, 1975; Spring and Capps, 1974; Tarver, Hallahan, Kauffman and Ball, 1976; Torgeson and Goldman, 1977). This failure might increase the likelihood that overlearning will occur.

An interesting research question then emerges. Simply put, for the learning disabled child, is the failure to use a given strategy due to a reduced processing capacity which, for example, does not allow him enough time to employ a strategy? Or, is the reduced capacity an outcome of some inability to employ strategies? In either case, the result for the LD child is an extreme loss in the efficiency of processing information which leads to the tendency of overload.

Of the many kinds of strategies that can be employed, perhaps the best research is verbal rehearsal in serial recall tasks. Young children do not spontaneously rehearse, however the skill increases with age (Appel, Cooper, McCarrell, Sims-Knight, Yessen and Flavell, 1972) and becomes more purposeful and conscious (Gibson and Levin, 1975). Chi (1976) stated that lack of rehearsal produces inferior performance, amount of recall is often a function of amount of rehearsal. Keeney, Cannizzo, and Flavell (1967) have shown that children who are "non-rehearsers" recall fewer items on serial recall tasks than "rehearsers." According to Keeney, et al. (1967), when six and seven year old non-rehearsers were induced to rehearse, they were able to recall as much as rehearsers.

It has also been shown that learning disabled children are non-rehearsers. Torgeson and Goldman (1977) found that poor readers failed to utilize any rehearsal strategies in a memory task. Tarver et al. (1976) also demonstrated that disabled children failed to utilize verbal rehearsal in recall tasks.

Gibson and Levin (1975) warn that verbal mediation may not be a useful strategy for higher-order cognitive tasks. Awareness of other useful strategies and self-testing might prove fruitful. Appel et al. (1972) found that fifth graders using rehearsal had poorer recall than children who did not employ the strategy. Rehearsal was negatively related to clustering (i.e., grouping by category). Clustering, therefore, might serve as an alternative strategy to rehearsal, especially for tasks which place greater cognitive demands on the learner. The effective use of categorical structure generally improves with age (Appel, et al., 1972).

Further discussion of strategies useful for productive learning appear in the sections on basic skill areas. The need for strategies to aid in the learning process seems clear. The particular strategy used depends on the nature of the material to be learned. It is possible that learning disabled children will not employ even the most basic strategies in a systematic and effective manner unless they receive explicit instructions to do so. The instructional conditions which encourage a child to learn and to employ strategies are not clearly delineated in the research literature (Gruenenfelder and Borkowski, 1975).

Characteristics of the Instructional Program

Programs designed for learning disabled youngsters emphasize a structured, hierarchical approach to teaching basic skills (Valett, 1969; Tarnapol, 1969; Hewett, 1974; Lerner, 1971; Frostig & Maslow, 1973; Gardner, 1974; Kaluger & Kolson, 1978). Training for transfer also appears to be a necessary characteristic of instruction for disabled learners.

The characteristics of instructional programs, however, have not received sufficient attention in the professional literature: overloading and interference. Overloading involves the amount of materials a child can manage within a given period of time. When too much material is presented, overloading is said to occur. The second factor, interference, is often related to overloading. Interference effects may account for forgetting over time.

Learning Hierarchies: The Importance of Prerequisite Skills. Prerequisite skills which are predictive of reading and/or spelling achievement have been considered from three theoretical perspectives. Studies based on task analyses are prevalent in the literature. Researchers who work within this framework try to break down an academic skill into its component subskills. During the last two decades, modality research has also been a popular avenue of inquiry. These studies often using an aptitude-treatment interaction model, focus on perceptual modalities and individual differences in modality preference in relationship to skill achievement. Research on cognitive strategies which predict success in skill areas is a third area of investigation. Analysis of errors and multivariate techniques are common in the strategy approach. Studies representing the three perspectives are described below.

A. Task Analytic Studies: A task analytic emphasis is based on the premise that reading consists of the proper performance of a large number of component sub-skills which are highly interactive. If an individual is deficient in any of the requisite sub-skills, a reading problem will ensue. The goal of reading researcher following such a scheme would hence consist of finding out the skills required for effective reading and developing remediation techniques to counter these deficiencies.

Recently there has been a great deal of attention paid to auditory skills related to reading. Of many relevant auditory skills, the two that have been most implicated in reading success are phonemic sequencing and blending (Phonemic synthesis).

Studies have shown that poor readers tend to experience difficulty in analyzing words into their constituent parts. For example, Calfee, Lindamood and Lindamood (1973) found that acoustic segmentation tasks adequately differentiated children as to high and low reading ability. The children

ranged from K through 12th grade. In another study by Hook and Johnson (1977), LD boys were found to be deficient in their phonemic segmentation ability. The task involved isolating sounds in nonsense words and pairing them with patterns of colored blocks. According to Liberman, Shankweiler, Fisher and Carter (1974) poor reading may be due to an inability to map the printed word onto the spoken word. Based on their developmental study, it was found that in a sample of pre-schoolers only forty-six percent could read criterion when attempting to segment words into syllables. None were able to segment into phonemes. Even by the end of first grade phonemic segmentation lagged behind syllabic segmentation.

The relationship between the ability to blend sounds and reading has also been widely documented. Chall, Roswell and Blumenthal (1963) have shown that auditory blending might be a factor underlying success in beginning reading. They found a substantial relation between ability to blend in first grade and reading ability in third grade. The correlation drops appreciably, however, by the time the child gets into fourth grade. Such a finding acquires relevance for special education if, as shown by Roswell (1954), LD children lag in their development of blending ability. Additional support comes from a study by Ramsey (1972) who found that forty percent of errors on a test of unfamiliar words by non-reading second graders were due to blending difficulties. Flynn and Byrne (1970) also found a significant difference between good and poor readers on auditory blending ability.

While blending ability has been demonstrated to be important in beginning reading, the role of blending training has also been shown to be an effective element of reading instruction. The primary benefit of blending training is in the area of transfer. Fox and Routh (1976) found that blending training reduced the number of trials required to learn a transfer list. For children who demonstrated the ability segment words in a review article dealing with the facilitory effects of phonics instruction on transfer, Ellis and Di Benedetto (1977) pointed out that blending is important in the transfer process. They concluded

that reading instruction would profit if blending and phonic analysis were included in the training.

Two other skills which have been consistently shown to be related to beginning reading achievement are knowledge of letter names and knowledge of letter sounds. Both of those skills are among the earliest factors in the history of reading research to be considered. In one of the older studies, by Wilson and Flemming (1938), it was found that letter naming ability correlated to a high degree (.79) with word recognition for kindergarden. The correlation dropped somewhat, but still remained high for both letter naming and giving letter sounds, for first graders. The authors also reported a high correlation-for-blending and word recognition.

The relationship of letter naming and letter sound ability with reading achievement has continued to hold up to the present, with those factors serving as one of the best predictors of reading readiness. For example, in a study based on eighty-four city kindergarteners, Richek (1977) found letter naming ability and knowledge of letter sounds followed by blending ability to be the best predictors of reading achievement when children were given phonics instruction.

Another factor which has been consistently related to beginning reading achievement is auditory discrimination. Richek (1977) has found auditory discrimination ability to be moderately predictive of word recognition skill. Others have shown that performance on tasks requiring discrimination of verbal stimuli may adequately differentiate retarded and normal readers (i.e., Blank, 1968; Hook and Johnson, 1977; Monsees, 1968).

An intriguing point is that reading, which on a common sense basis would appear to be highly influenced by visual perceptual factors, does not appear to be related to skill in visual discrimination. Apparently, if an individual's visual perceptual mechanism is unable to handle the rudimentary level of visual discrimination displayed by even the most retarded reader, then reading diffi-

culties may be the least of his problems. Reviews of the visual perceptual deficit literature may be found in Barrett (1965) and Vellutino (1978)

B. Modality Studies: Chall (1978) notes in her review of the literature on learning disabilities in reading that great emphasis has been placed on visual and auditory perceptual deficits and their relationship to language arts achievement. A visual deficit has been proposed as a cause of reading failure. Early studies (Wolfe, 1941) noted the high incidence of letter reversals in the oral reading of poor readers. However, a series of studies by Vellutino and his colleagues (1972, 1973, 1975) indicate that poor readers were no worse than their normal peers on encoding 3 or 4 letter words presented in a visual mode or on a visual scanning task.

Auditory deficit research also appears to be inconclusive. Hammill and Larsen (1974) reviewed 33 studies that related auditory skills to reading ability. Because many of these studies were not sufficiently controlled, and results are contradictory, the authors concluded that evidence for an auditory deficit is inconclusive at best.

Cross-modal studies also yield inconclusive findings. A series of studies which involve cross-modal matching (Blank and Bridger, 1966; Blank, Weider and Bridger, 1968; McGrady and Olsen, 1970; Steger, Vellutino and Meschoulam, 1972) indicated that any difficulties poor readers exhibit can be accounted for by verbal encoding deficits rather than perceptual deficiencies.

Despite the inconclusive evidence supporting the perceptual deficit hypothesis, research on modality preference has been a popular area of study. Tarver and Dawson (1978) reviewed 15 aptitude-treatment studies and concluded that results are confounded by instruments with low reliability and validity. The studies lack comparability because of differences in duration, definition of method, and measurement of achievement. Despite these problems, Tarver and Dawson noted that 13 out of 15 studies found no significant interactions between modality preference and treatment. In addition, although a few studies show a superiority for a visual teaching method, across all types of subjects

results are clouded by the short duration of the training and by the fact that auditory training consisted of listening tasks as opposed to actual reading. Longitudinal studies indicated a superiority for auditory-phonics training.

C. Strategy Studies: Several recent studies have examined particular strategies that might predict success in skill acquisition. Barr (1975) analyzed word recognition errors of first graders taught by phonics and sight word methods. Her findings are quite interesting. A large number of children taught with a phonics method tended to use a sight-word strategy (replacing the actual word with another sight word in their repertoire) initially. In general, over the course of a semester, many of these children changed their set and began to use a phonics strategy (high percentage of phonetically similar non-word substitutions). Sight word training did not yield great changes in the children's strategies. Since the initial strategy was suitable for the method, there was very little crossover to a phonics strategy. However, a few highly successful children taught by the sight-word approach did use phonic analysis. It would appear that in general, different types of instruction require their own particular strategies.

Barr's findings are consistent with those of Richek (1977). Richek used a multivariate design to evaluate a number of proposed predictors for success on sight of word and phonic reading tasks. She found that the ability to name letters appears to be a "g" factor for both tasks. There are also specific predictors for each task. In the case of sight words, visual discrimination and digit span appeared to be good predictors of performance. Richek concluded that the fact that visual discrimination was a better predictor than visual memory indicated that children might be using a specific strategy with the material. Since an auditory and visual skill were the best predictors, the modality emphasis did not seem to have explanatory power. On word learning with a symbol-sound emphasis, letter sound knowledge and blending ability explained the highest percentage of the variance. Richek's data also

lends support to the task analytic viewpoint.

Different cognitive abilities strategies may be more related to spelling achievement than reading. Nelson and Warrington (1974) found that children who were adequate readers but poor spellers made more phonetically accurate errors in spelling than children who were poor in both areas. Children who showed both reading and spelling retardation exhibited a more generalized underlying language deficit. For children with only spelling problems, the underlying deficit is unclear. To some extent, good spelling and consequently greater transfer of training can be accounted for by the learning of the sequential probability of specific letters on phonetic generalization, or both (Wallach, 1963). There is also evidence to indicate that good spellers also use an imagery process which allows them to generate possible spellings and select the correct match with the stored visual representation. The imagery model however, may apply only to nonphonetic words. Walker (1974) found interaction between imagery ability and type of spelling words. While there was no overall main effect for visualization ability on spelling performance, good visualizers performed better than poor visualizers on words having little or no phon-graph consistency. A pilot study which used first and second graders gave limited support to the notion of visualization (Smith, 1976). First graders who were good spellers tended also to perform well on tasks requiring retention and reproduction of a word presented in the presence of competing visual configurations. Phonetic ability was not a good predictor of spelling performance. However, the visualization factor did not hold up for second graders. The author concluded that phonetic knowledge gained from classroom instruction could have served as a source of interference with the visualization process.

Transfer of Learning: Practically all educational and training programs are built upon the premise that human beings have the ability to transfer what they have learned in one situation to a slightly different situation (Deese, 1958). The goal of education is not only to be able to retain what is learned, but to transfer that learning to a new and somewhat different task. Transfer can also have a positive effect on prior learning; subsequent learning can help to generalize, keep in memory and associate what has been learned before (Frostig and Maslow, 1973).

Research in the field of transfer of training has helped to identify those variables that facilitate transfer as well as some conditions that inhibit the transfer of a learned skill to a new task. The earliest studies of Thorndike and Woodworth (1901) indicated that similarity of stimulus to transfer task is an important criterion for the facilitation of transfer. They concluded that positive transfer occurs as long as certain task elements are identical. Others (Vellutino, Steger, Moyer, Harding & Nils, 1977; Ellis, 1965) have confirmed the principle that the greater the similarity between the new situation and the previously learned set, the greater the degree of transfer.

Using the principle that similarity of stimuli enhances the ability to use previous learning in new situations, an effective teaching method would be the analysis of component parts of a task, organizing the components into discreet steps along a simple to complex continuum, and teaching the series of steps that lead to the more complex skill. It would be important to emphasize the similarities between the series of tasks (Baker and Osgood, 1954).

The learning disabled child usually experiences difficulty in being able to see the relationship between parts and whole. For this child to learn complex tasks it is mandatory that tasks be broken into small, discreet, hierarchical steps. He may not be able to perceive the relationship of one step to the next in a series, therefore it is necessary for the teacher to deliberately provide the disabled child with pointed information about the similarity of stimuli (Vellutino, et al., 1977; Ellis, 1965; Frostig and Maslow, 1973). The teacher cannot assume that the child will automatically transfer or apply this newly

formed skill without direct assistance. The teachers must take definite steps to help the child to utilize experiences and find applications to new situations (Klausmeier and Goodwin, 1966). Ferguson, (1956) believed that higher order abilities involve the integration of previously learned skills which have direct transfer value. Gagne (1970) agrees that complex skills are the end result of a hierarchical ordering of transfer skills that vary from one stage of development to the next.

Since transfer takes place when learned skills are applied in new contexts, a child must learn how to discriminate salient features of the task stimuli. This raises the question of how to teach a child to discriminate salient features among the task variables. Experts agree that when the learner does not identify the problem as an opportunity to apply previous knowledge there will be little transfer (Ellis, 1965).

These findings suggest that children must be directed to see the similarity of salient features (Travers, 1972). For example, words that are presented on cards must be recognized when they are on the printed page of a book. The learning disabled child needs to be helped to see the visual similarity of the letters.

Although it is easier to transfer learning to similar stimuli, it is difficult to discriminate salient features of a task when there is a great deal of similarity among task stimuli. In order to discriminate salient features of task stimuli, comparison of features is an essential ingredient. Therefore there is a need for a variety of stimulus clues in the original training (Callantine and Warren, 1955). If the stimulus differences are not too small or too large, the stimulus relations are potential cues (Reese, 1968). Transfer is a function of the degree of variation in the original training (Duncan, 1958; Crafts, 1927; Restle, 1958).

In a study by Zeiler and Paalberg (1964), one group was given disparate training sets while another group was given training with very similar stimuli. The group trained with the similar stimuli failed to notice the difference between sets and received, in effect, single problem rather than multiple problem training. They were less able to transpose their training to new learning sets.

Multiple problem training should increase the probability of transposition (Reese, 1968). In multiple problem training the child experiences more variety in the relevant stimulus dimension than in single problem training. This additional experience provides an opportunity to grasp the relational aspect of the learning problem (Johnson and Zara, 1960; Rosenthal and Zimmerman, 1976).

These studies suggest that it is necessary to introduce a child to many variations of a particular skill. For example, when a child is learning to recognize the letters of the alphabet he must have the experience of identifying them on the blackboard, on a card and in a book. He must be able to recognize the letter in isolation as well as embedded among other letters. He needs to be aware of those features that set one letter off from another and those features that provide cues to letter recognition in various settings. It is necessary to directly teach a child these discriminative features and to use as many varied teaching materials as possible to strengthen associations (Vellutino, et. al., 1977).

The amount of practice on the original task is an important variable in the enhancement of transfer (Gagné and Foster, 1949). Transfer is a function of practice effects, both in the general factors such as learning various modes of attack or learning how to learn, and in specific factors such as the similarity between task features and task responses (Marx, 1969). Transfer is maximized when greater effort is spent on the mastery of early tasks in a related series of tasks (Ammons, Ammons and Morgan, 1956). The more extensive the practice on the original task, the greater the transfer effect. Positive transfer increases as the amount of first task practice increases (Duncan & Underwood, 1953; Underwood, 1949).

The relevance of the initial training increases when the direction is from easier to harder tasks (Baker and Osgood, 1954). This finding supports the need for a breakdown of complex tasks into a hierarchical series of small steps. When children are able to reach mastery on the easier tasks, they are able to transfer these skills to the more complex tasks with greater effectiveness (Bryant, 1965b). Some educators (Frostig & Maslow, 1973) believe that overlearning contributes to increased transfer. Therefore, teachers must program their materials so that a child has sufficient exposure to a skill before introducing the child to the next more difficult level and not until he has proven his mastery of the simpler skills.

Judd (1908) believes that transfer is enhanced when the easier task enables the learner to discover the relevant cues necessary for the solution of the more complex task. Gagne and Brown (1961) agree that guided discovery of relevant cues is better than direct instruction. Other studies conclude that derived principles are more transferable than principles given to a student (Archer, 1930; McGeoch, 1952). Vellutino, et al. (1977), however, disagree. They believe that children need direct instruction in discriminating salient features. Especially among the learning disabled, the teacher must provide direct teaching of discriminative features. Teachers should select and emphasize elements which students can use in the transfer of skills, and they must help the disabled learner to understand and to apply learned skills to new situations (Olmo, 1975).

In order to transfer learned skills to new tasks it is necessary to perceive the similarities and to discriminate the differences that exist among task stimuli (Frostig & Maslow, 1973). This is the process of conceptualization. Klausmeier and Goodwin (1966) describe the learning of concept formation as attending to the similarities and differences among things and events, acquiring verbal labels and recognizing the hierarchical order. McDougall (1958) demonstrated that concepts based on a relatively large number of facts were retained

better than facts per se and showed a greater possibility of transfer. Rules or principles taught to students facilitated the attainment of successive concepts of the same class (Wittrock, 1963).

Research on transfer of learning with normal and LD populations tends to be fairly consistent. There are particular ways to present information which will encourage the individual to transfer it to novel situations. It is important to emphasize similarities among stimuli by allowing the individual to discriminate salient features. Training needs to be varied so that the learner can make comparisons and solve multiple problems. Practice in specific areas must be sufficient and material must be arranged in a hierarchy from simple to complex. For the learning disabled population, specific training for transfer may be crucial for academic achievement to be possible.

Overloading: Overloading occurs when the amount of information to be processed within a given time span exceeds the individual's capacity. Such a view would be congruent with that of Broadbent (1958), who held that it would be useful to regard the entire nervous system as a single channel which has a limit to the rate of information it can handle. In his words, "...a man will be unable to manage within a fixed period of time to cope with more than a fixed number of signals" (Broadbent, 1971, p. 8).

According to the above definition, a condition of overloading would depend on two parameters: amount of information to be processed, and the amount of time allowed the individual to process that information. Both are more or less amenable to accurate measurement and could be determined by both internal as well as external factors. For example, in a classroom the teacher has control over both the amount of information presented to the student and the amount of time allotted for a given task. Internally, a given amount of information which would create no problem for one child, if presented to another child, who could hold only a small number of items in immediate memory, may constitute an insurmountable load. Similarly, the speed at which the child processes the information will determine whether or not overloading occurs. A processing speed which is too slow will have the same effect as an excessive rate of presentation.

There exist a number of potentially measurable factors associated with amount of information or processing speed. Informational variables might include the difficulty of the material, the organization of the material, the degree of familiarity with the material, affective value and redundancy. Factors which affect processing speed may include degree of arousal (i.e., anxiety level), fatigue, health, etc.

James Miller (1964) provided a good description of the condition of overload. According to him, a curve describing the development of overload would indicate a generally linear relationship between input and output until the

channel capacity of the organism is reached. The curve would then level off and finally exhibit a sharp decrease. Because of the small sample size in Miller's study, only tentative conclusions can be drawn. Nevertheless, his findings provide useful information.

Miller also observed that at higher input rates, "adjustment processes" were employed by his subjects. These serve to maintain output and might be viewed as concomitants of overloading. He specified eight adjustment processes: 1) omission - failure to process information; 2) error - processing information incorrectly; 3) cueing - delaying responses during heavy load periods and catching up during any lulls that occur; 4) filtering - systematic omission of a certain type of information; 5) approximation - a less precise response given because there is no time for details; 6) multiple channels - making use of parallel sub-systems, if the system has them at its disposal; 7) decentralization - a special case of multiple channels; and 8) escape - either leaving the situation or taking other steps which cut off the input of information.

Miller's work is unique in that it focused directly on overloading. There are a few other studies which, while they are only indirectly related, may shed some light on the issue. These studies seem to indicate that the speed of information processing is a reliable factor and that it may be related to verbal and school performance.

In a recent study, (Spiegel and Bryant, 1978) found that the speed of processing information correctly, as measured by mean response time, and slope of the response time for tasks of varying levels of complexity, was reliably related to intelligence.

Das (1973), in a factor analytic study employing 9-11 year old subjects found that in addition to two modes of information integration (successive and simultaneous), a third factor, speed, related to tests of reading time, visual short term memory, and cross-modal coding task performance.

A study by Yen (1978) was based on a sample of 5th-10th grade Californian

youngsters. Her subjects learned meaningful as well as non-meaningful material. She utilized an information processing model to identify the components of informational learning in her sample. One component identified was the amount of information encoded on each trial into what she believed to be long-term memory (i.e., acquisition rate). The other component was the amount of information retained after a four day period. Rate of acquisition and retention were found to be independent of one another. Yen suggested some practical educational strategies which her findings implied: for those students with a low acquisition rate, the teacher should spend more time on the information, while for those students with low retention, the teacher should frequently review previously learned material. A study of learning curves in retarded readers conducted by Camp (1973) is related to Yen's (1978) findings. Camp concluded that individual differences in learning rates could account for differential levels of reading achievement.

There is evidence which demonstrates that learning disabled children do, in fact, process information at a slower rate than non-disabled children (Hunt, Lunneborg & Lewis, 1975; Spring, 1971; Spring and Capps, 1974). Hunt et al. (1975) found that college freshmen who were low in verbal ability processed information at a much slower rate than those who were high in verbal ability. They maintained that verbal ability is highly related to the rapidity of coding and manipulation of verbal stimuli. In a study conducted by Spring (1971), reading disabled children took more time than normals to process information, as measured by reaction time on discrimination tasks. As reported by Spring and Capps (1974), reading disabled boys displayed a much slower encoding speed than normals. Encoding speed was measured by having the children name digits, color plates and pictures as rapidly as possible.

Another factor which comes into play when considering processing efficiency is the degree to which a given skill is automatized. Automatized behaviors are those which have been so practiced as to require a minimum of conscious effort for their efficient criterion. Automatized behavior would be typified by

walking, maintaining posture, and for the non-learning disabled child, talking, reading and writing (Eakin and Douglas, 1971). A tenable assumption regarding the tendency to overload is that when behaviors are automatized, a much smaller amount of an individual's processing capacity need be utilized for the execution of a given task. If an individual is forced to devote ongoing processing capacity ("conscious effort") to portions of the task which should be automatized, less capacity remains for other aspects of the tasks, making the individual more susceptible to overloading.

In an investigation of automatization, Eakin and Douglas (1971) found that poor oral readers demonstrated considerably inferior performance on all tasks requiring rapid response rates to common familiar stimuli. The tasks the subjects were tested on included: naming color hues, naming repeated objects, and word color interference. The poor readers performed at least as well as controls, however, on tasks which did not require automatized performance. Denckla and Rudell (1976) found that tests of automatized naming of colors, objects, numbers and letters reliably differentiated learning disabled from normal readers.

In a study which related encoding speed to rehearsal ability and probed recall, Spring and Capps (1974) found that reading disabled boys were much slower than good readers on encoding tasks. Ages ranged from 7-6 to 13-4 years. Encoding speed was measured by asking the children to name digits, color plates and pictures as rapidly as possible. Memory was tested with a probed recall of digits. According to the authors, "dyslexic" boys were much slower than normals when naming the test items, and were especially slow when naming digits.

On the memory task in this study the serial position curves for the "dyslexics" displayed a loss of the expected primacy effect, which is shown by an anomalous flattening for the earlier items, and indicates a reduced tendency for rehearsal. Since, in their experiment speed of processing was highly predictive of memory performance, Spring and Capps (1974) reasoned that it

was because of their slow processing speed that the "dyslexics" were unable to rehearse the material.

One of the most common behavioral characteristics attributed to learning disabled children is distractibility. Hallahan (in press) has reviewed numerous studies which indicate that disabled children are not as able as normals to attend to relevant stimuli and ignore irrelevant stimuli. While distractibility may seem to be more a factor related to selective attention, it may also be considered as a factor which is involved in overloading. If one views attention as the allocation of processing capacity, as advocated by Senf (1972) and Kahneman (1973) attending to irrelevant stimuli would involve either using up a portion of one's limited capacity, or adding to the processing load created by an ongoing task. One would then become more prone to overloading.

There are several studies which support the above notion that distractions increase processing load. Eriksen (1955) found that as the number of signals or objects in a visual display was increased, the time required for the visual location of a constant number of specific signals also increased. According to Rabbitt (1964), the speed with which relevant and irrelevant stimuli are discriminated from each other depends on the number of other stimuli from which the subject has to search. Goldstein and Allen (1971) also found that it took longer to process information when irrelevant stimuli were present.

Further support comes from investigations of the "response-prefix effect." The poorer recall of a memory series when a subject is required to interpolate a redundant element between the presentation and recall of the series, than when no prefix is required is termed the response-prefix effect. Jahnke and Nowaczyk (1977) utilized memory for an auditorily presented digit series in their study and found that recall of a series was poorest when the prefix consisted of a digit which was a stimulus from the same class of material as the target series. Through systematic manipulation of the degree of complexity of response prefixes, the above investigators were able to determine that the

response-prefix effect is due to demands made on the processing capacity of the individual. In line with the above, Shumaker (1971) found that with visual presentation, the degree of similarity between the prefix and the target series determines the magnitude of the response-prefix effect.

Additional support for the rationale that distractors use up capacity comes from a study conducted by Karsh and Monty (1972), who found that when irrelevant information which closely resembled relevant information was introduced into a task requiring subjects to keep a mental tally of a sequence of letters, performance was disrupted. The detrimental-effects were eliminated when cues which assisted a paced rehearsal were inserted into the series.

In a study investigating the effects of distraction on learning disabled children, Lasky and Tobin (1973) asked first graders questions about verbally presented material. Two varieties of distractors were employed: white noise and tape recorded voices. The disabled children's performance did not differ from that of the normal children.

Certain tentative conclusions can be drawn from the literature on the subject of overloading. First, overloading may be said to occur when the amount of information to be processed within a given time span exceeds the individual's capacity. Secondly, a condition of overload depends on two parameters: amount of information to be processed and the amount of time allowed the individual to process that information. Third; internal as well as external factors would affect the above parameters. External factors are for the most part under the control of the experimenter or teacher, i.e., amount of information to be presented to child for a given lesson, and amount of classroom time allotted. Internal factors may lead to a functional increase in information load, i.e., lack of experience, poor immediate memory, etc. Also, factors such as stress, fatigue, illness, etc. may reduce the child's speed of processing. Finally, four factors which make the learning disabled child susceptible to overloading were discussed: 1) slow speed of processing of

the disabled child; 2) failure to automatize and early fatigue which prevents overlearning; 3) failure to use strategies; and 4) distractibility, leading to unnecessary processing of irrelevant information.

Learning disabled children appear to have a greater tendency to overload than normal learners. A slow speed of processing, which often creates the situation, can be compensated for by careful pacing. The rate of presentation of material needs to be monitored and regulated. In addition, the effect of distractibility, which contributes to an already overburdened processing capacity, can be minimized by removing irrelevant cues from the task.

Interference. The second major factor generally ignored in the professional literature on learning disabled youngsters is the effect of proactive and retroactive interference. Retroactive interference (inhibition) is said to occur when new learning interferes with material learned at an earlier time. Kagan and Havermann (1968) claim that this kind of backward interference has a much greater effect upon meaningless information and specific details than upon basic principles underlying meaningful learning.

Proactive inhibition, which relates to negative transfer, occurs when old learning interferes with new material. Again, this type of interference is generally stronger with meaningless rather than with meaningful materials.

Interference (both retroactive and proactive) effects from previously learned material have been attributed to response competition. Early experimental procedures designed to study the effects of response competition in short-term recall (Underwood, 1948; Barnes and Underwood, 1959) show that at the time of recall, if a subject has more responses available, and he must make a selection from responses, the likelihood of error is greater. More recent studies (Peterson, 1967; Wickens, Born & Allen, 1963) lend support for response competition. Results show that performance may be perfect on initial trials of learning tasks, but then declines across subsequent trials as the number of response alternatives increase.

When attempting to apply the concept of response competition to classroom

instruction, it seems valid to assume that old responses may be forgotten and new responses may be more difficult to acquire if the number of response alternatives does not remain stable across trials. For example, interference may occur when attempting to learn a new sight word (new response) if previously mastered words (old responses) have not been excluded from the learning trial.

Implications for Future Research

While there is consensus on the notion that instruction for disabled youngsters must be designed with sound learning principles in mind, research data on the application of these specific principles to instruction is limited. With the exception of reinforcement, these instructional variables have seldom been manipulated experimentally or systematically studied in investigations involving LD youngsters. LD research to date has focused largely on neuropsychological and/or cognitive processes which are associated with underachievement on school-related tasks.. Findings from aptitude-treatment interaction studies, however, do not lend support for the proposition that the answer to instruction for poor achievers is to create a "fit" between learner and teaching methodology.

It would be fruitful to explore whether instructional conditions (e.g., teaching to a level of mastery, providing review, focusing on salient cues, and teaching for transfer) are critical factors regardless of specific method of instruction. The review of existing literature points to two important questions which need to be examined: 1) Does the application of sound learning principles have a differential effect on the achievement of disabled vs. normal youngsters? and 2) What effect does varying the degree of application of these principles have on achievement? Research activity generated by these broad questions can help to delineate characteristics of the LD population and to design curricula across a variety of subject areas which would be suitable for that population.

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